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Aida

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(54) **DIVERGING DEVICE WITH OADM FUNCTION AND WAVELENGTH DIVISION MULTIPLEXING OPTICAL NETWORK SYSTEM AND METHOD THEREFOR**

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H04J 14/02 (2006.01)

(52) **U.S. Cl.**
CPC ***H04J 14/0227*** (2013.01); ***H04J 14/0201*** (2013.01); ***H04J 14/0204*** (2013.01); ***H04J 14/0205*** (2013.01); ***H04J 14/0221*** (2013.01)

(58) **Field of Classification Search**
CPC H04B 10/296; H04J 14/0221
USPC 398/45–64, 83
See application file for complete search history.

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(57) **ABSTRACT**

The present invention does not require control and path switching by terminal station equipment and prevents the deterioration of signal quality when a cable failure occurs. A wavelength diverging device connected with three or more stations monitors an uplink signal received from each station, and when detecting the absence of an uplink signal received from any station, outputs dummy light instead of the absent signal, performs multiplexing/de-multiplexing for the dummy light and an uplink signal received from a station excluding said any station, and outputs the multiplexed/de-multiplexed signal. All of said processes are performed within the wavelength diverging device.

17 Claims, 7 Drawing Sheets

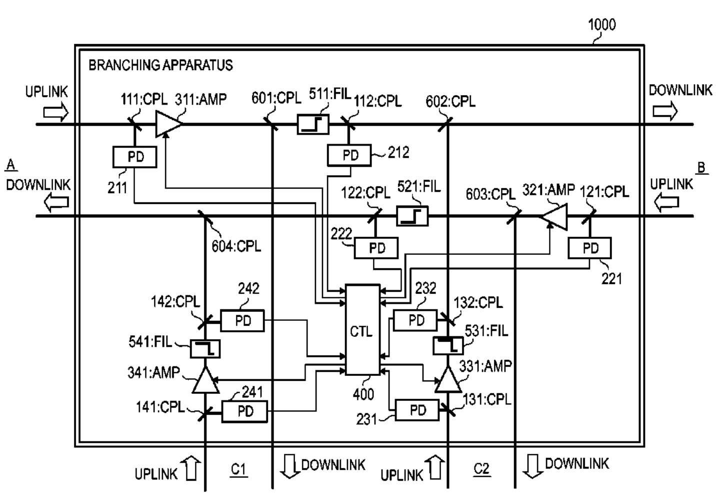

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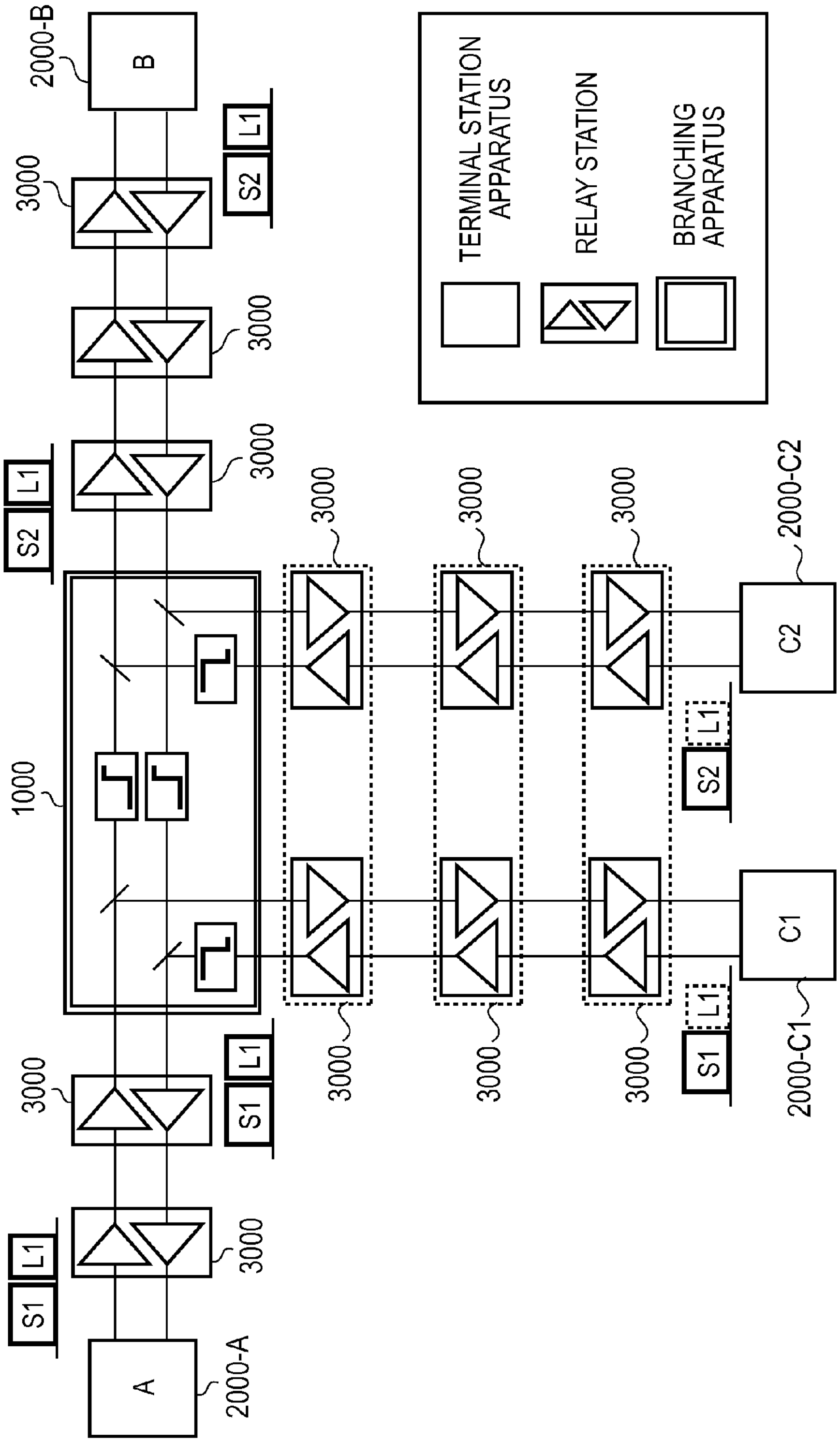
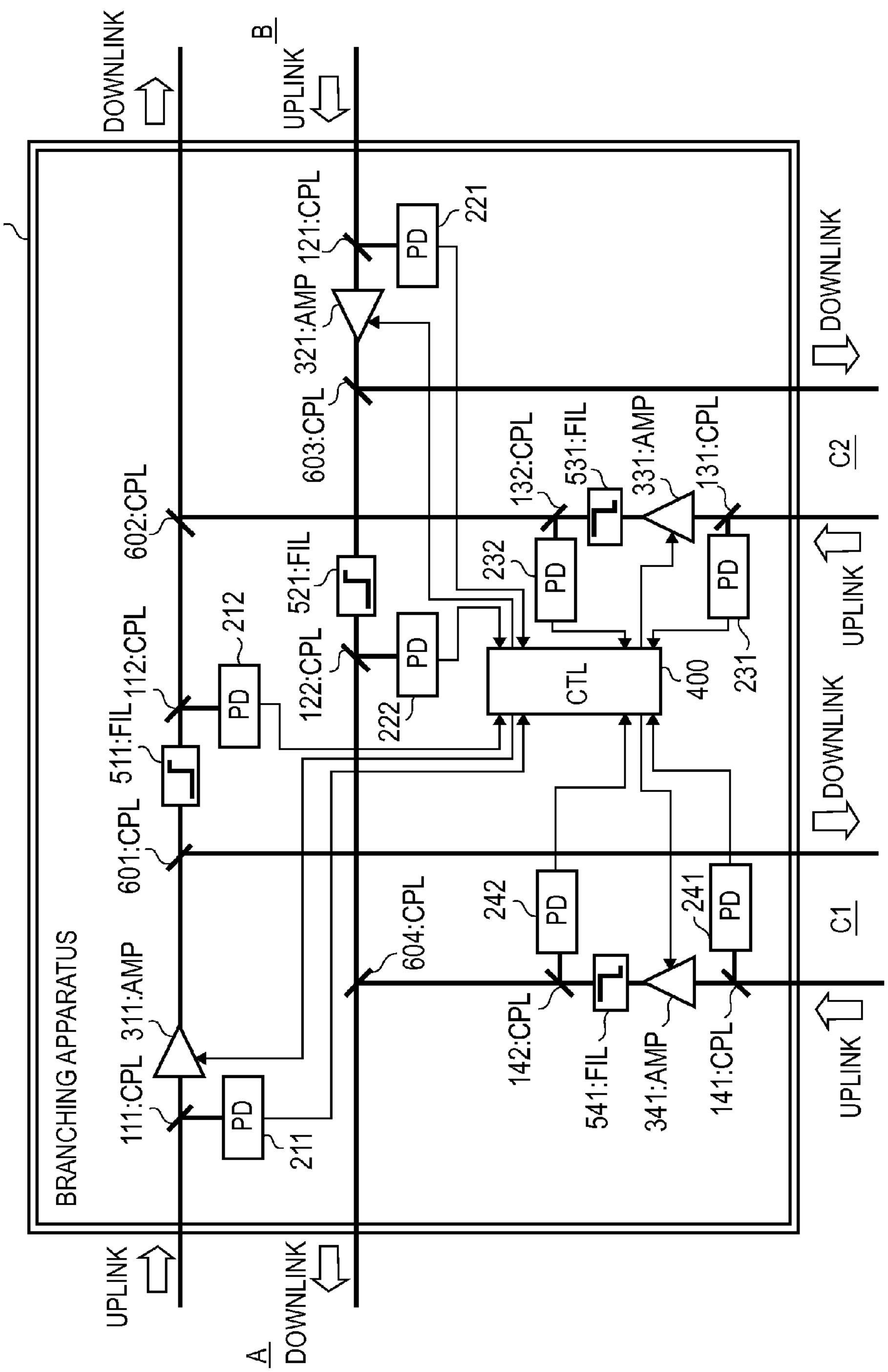
FIG.1



A
B
C1
C2
2000-A
2000-B
2000-C1
2000-C2
1000
3000
S1
S2
L1
TERMINAL STATION APPARATUS
RELAY STATION
BRANCHING APPARATUS

FIG.2



1000
BRANCHING APPARATUS
UPLINK
DOWNLINK
A
B
C1
C2
111:CPL
311:AMP
211
PD
601:CPL
511:FIL
112:CPL
212
602:CPL
604:CPL
122:CPL
222
521:FIL
603:CPL
321:AMP
121:CPL
221
CTL
400
232
132:CPL
531:FIL
331:AMP
131:CPL
231
242
142:CPL
541:FIL
341:AMP
241
141:CPL

FIG.3

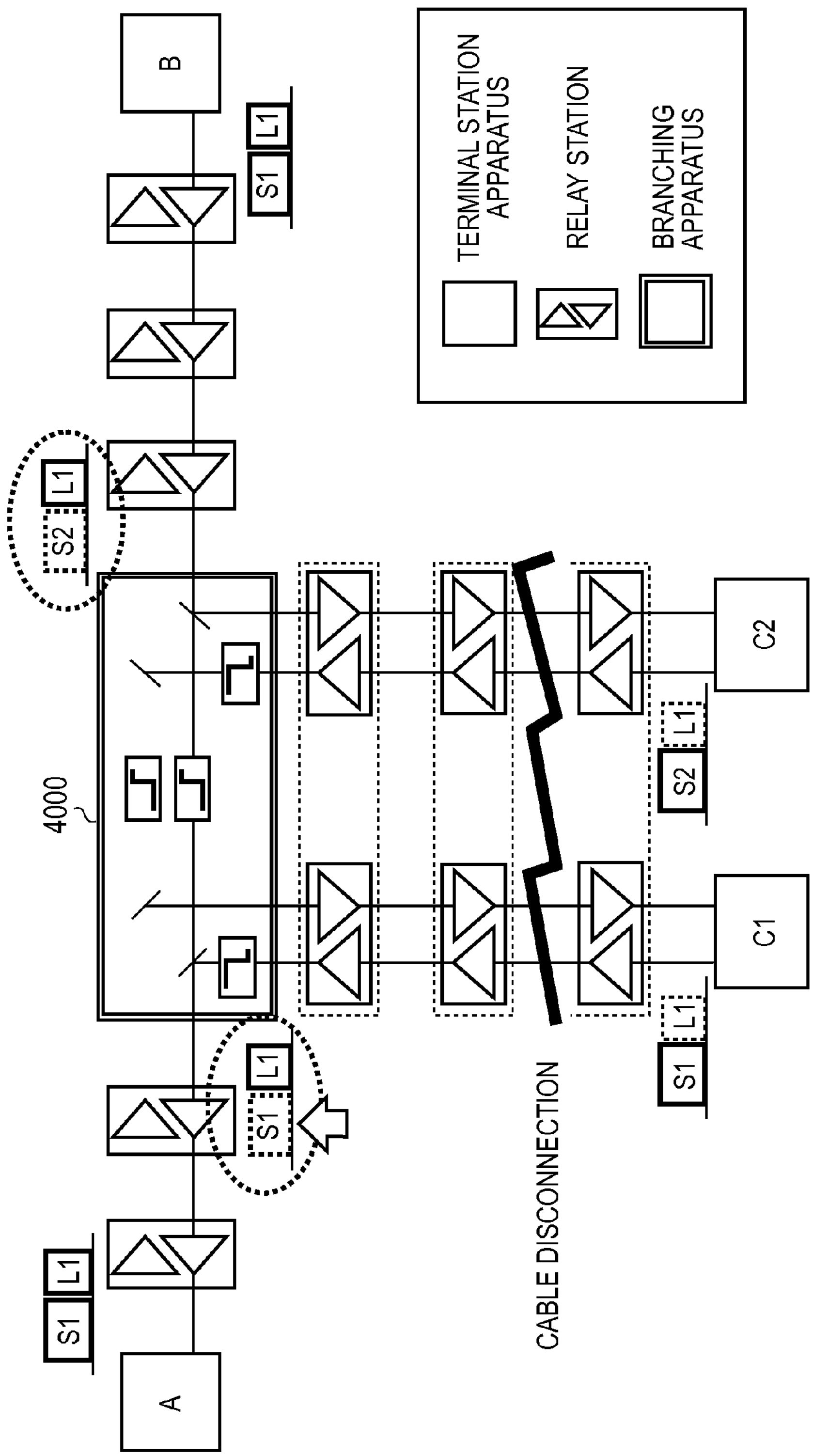

A
S1
L1
L1
S1
4000
L1
S2
B
S1
L1
TERMINAL STATION APPARATUS
RELAY STATION
BRANCHING APPARATUS
CABLE DISCONNECTION
C1
C2
S1
L1
S2
L1

FIG.4

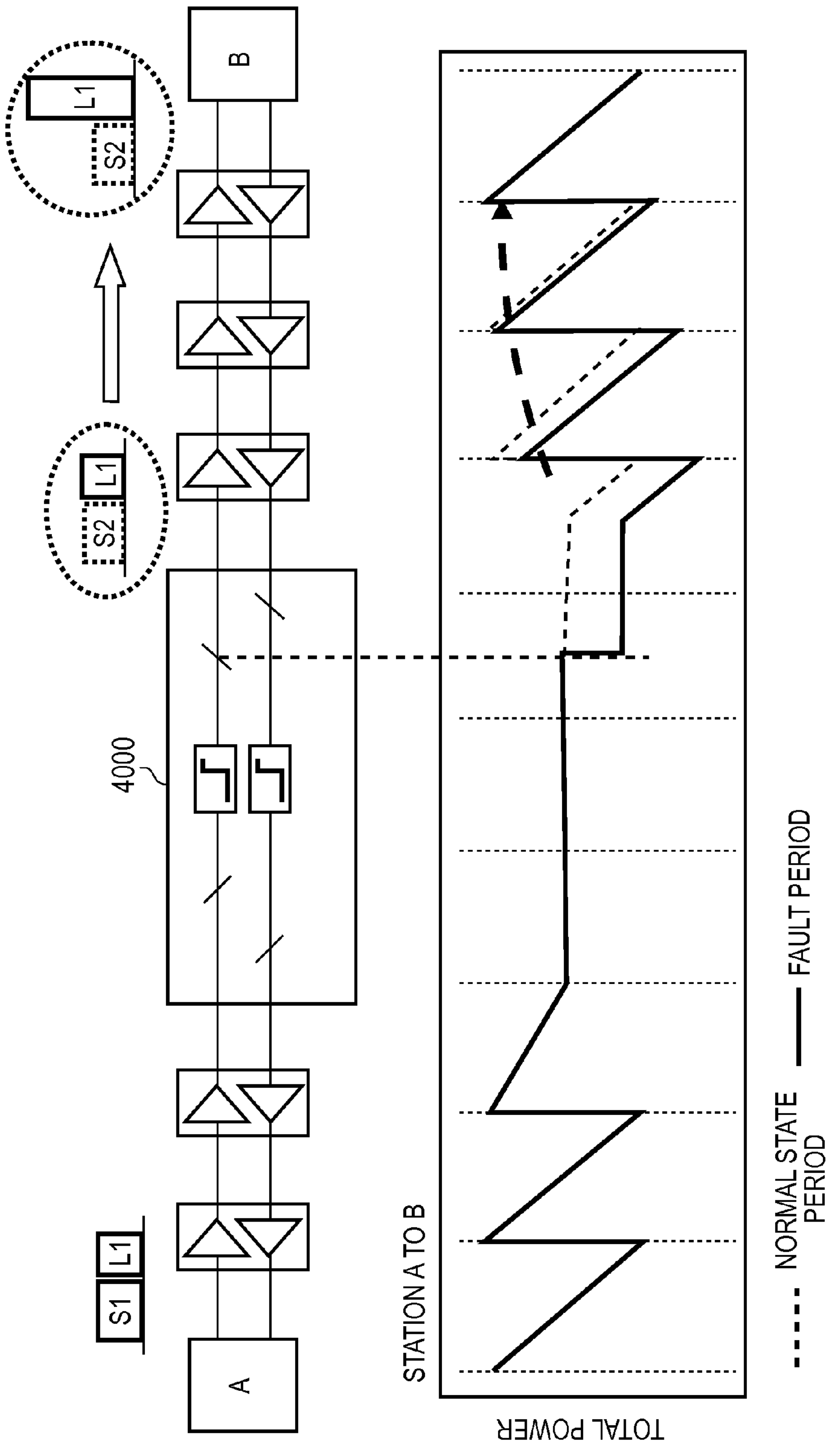

A
B
S1
L1
S2
L1
S2
L1
4000
STATION A TO B
TOTAL POWER
NORMAL STATE PERIOD
FAULT PERIOD

FIG.5

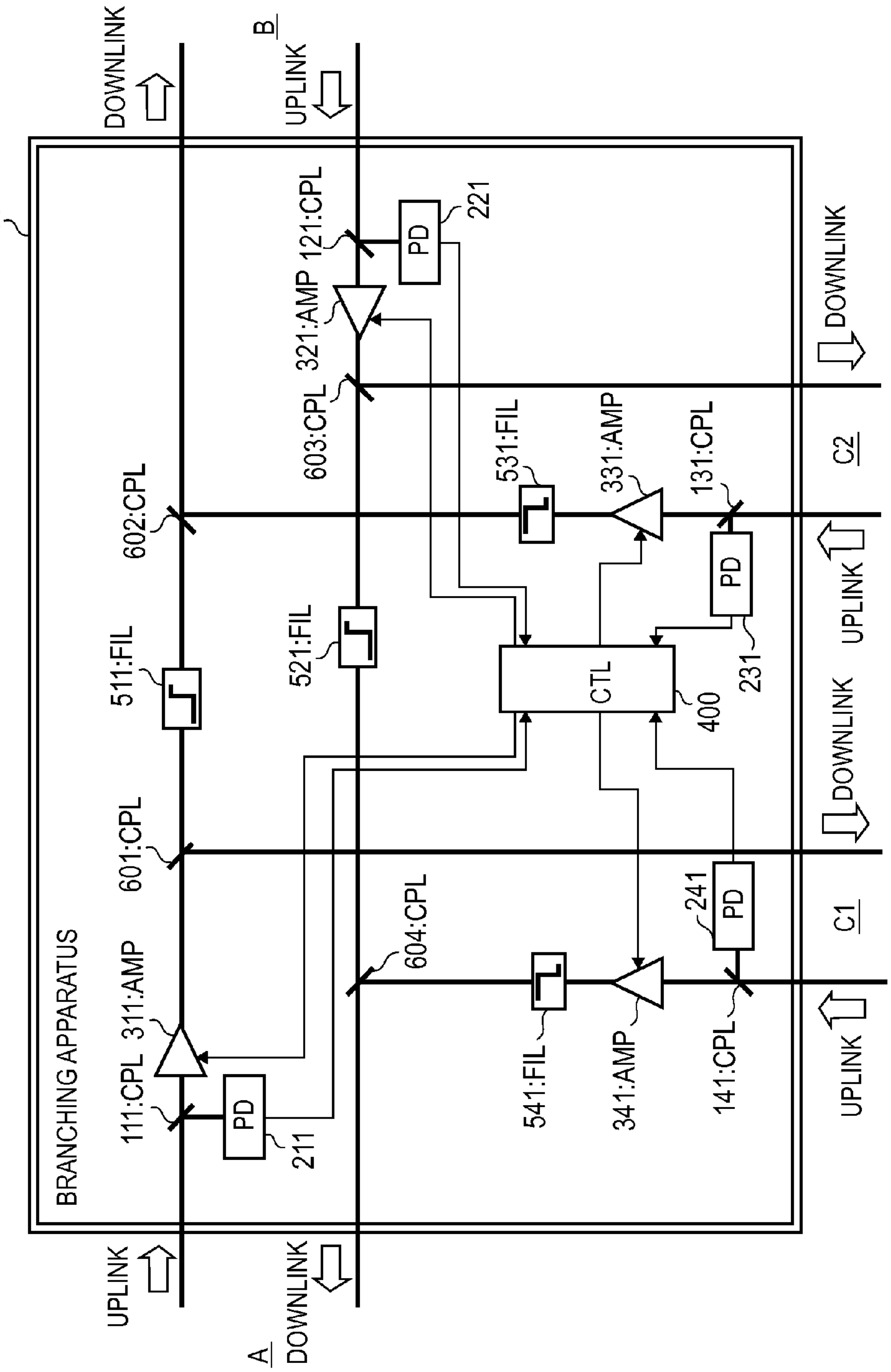

1001
BRANCHING APPARATUS
DOWNLINK
UPLINK
B
A
C1
C2
111:CPL
121:CPL
131:CPL
141:CPL
211
221
231
241
PD
311:AMP
321:AMP
331:AMP
341:AMP
400
CTL
511:FIL
521:FIL
531:FIL
541:FIL
601:CPL
602:CPL
603:CPL
604:CPL

FIG.6

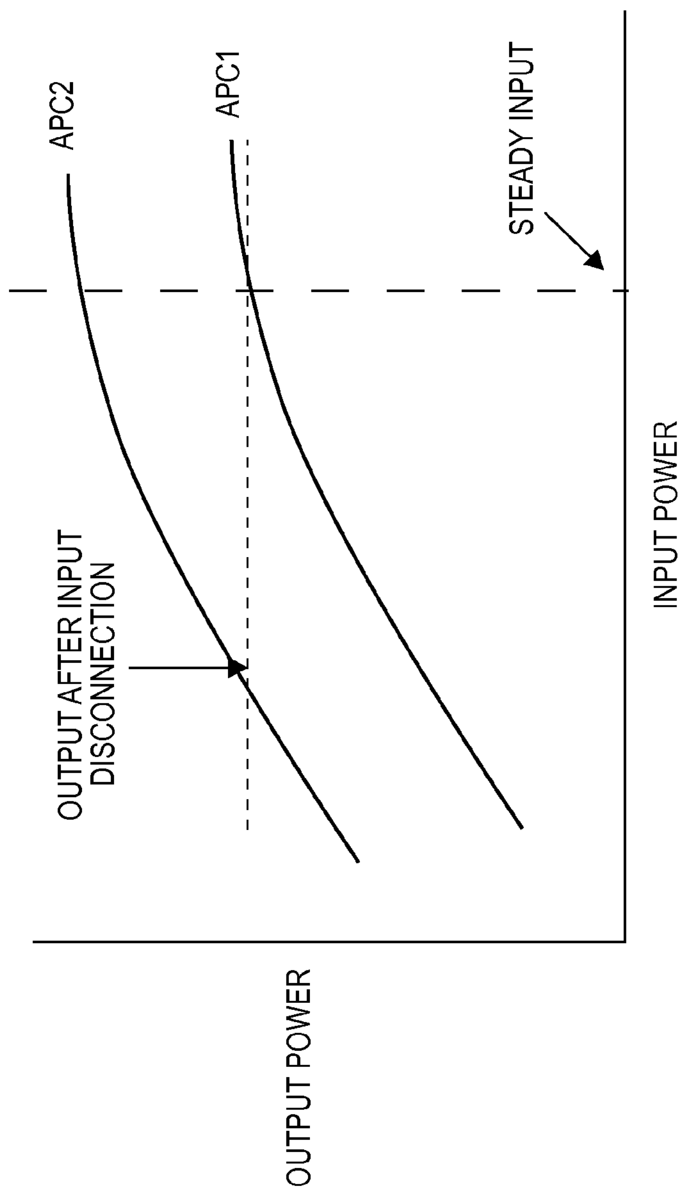
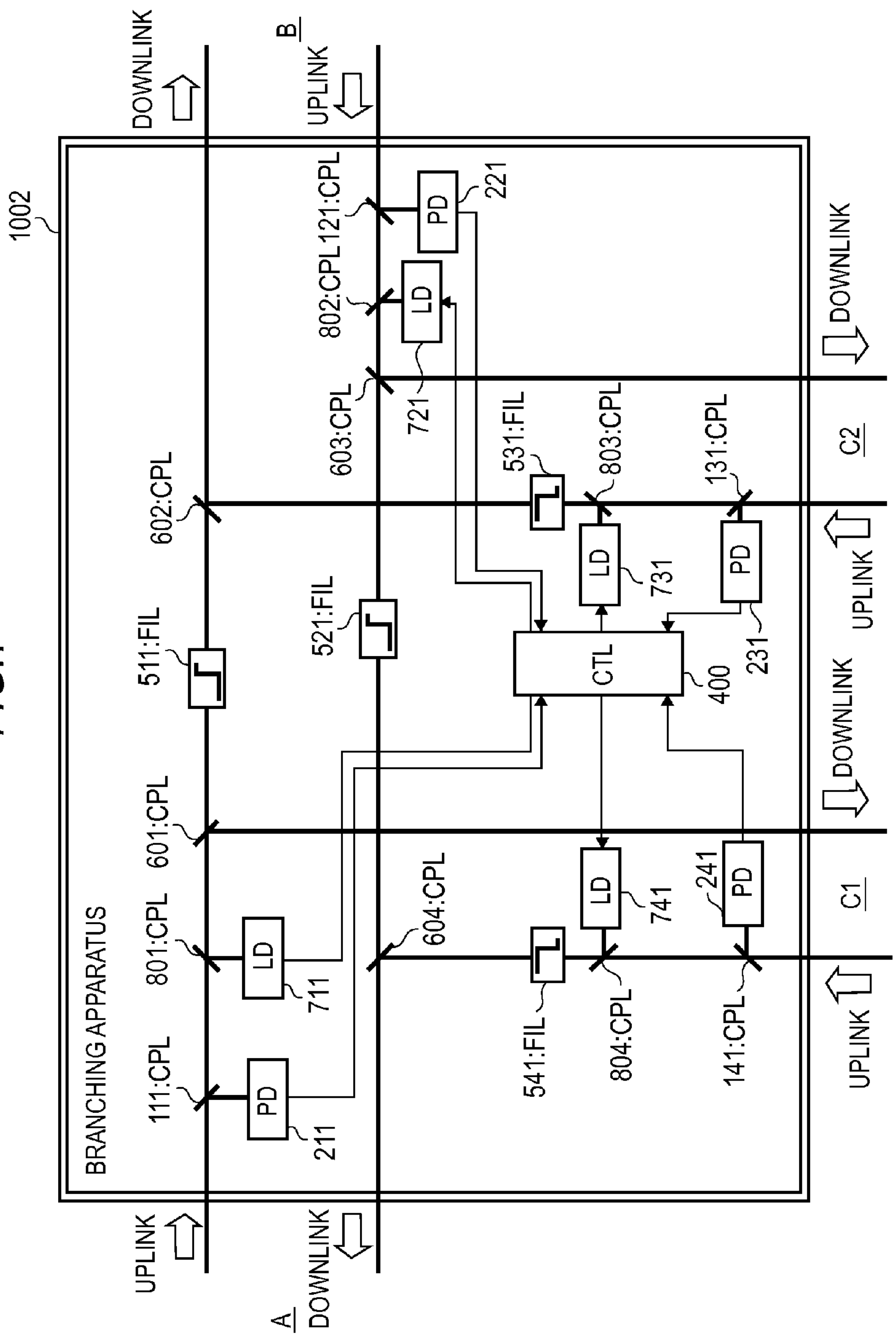

APC2
APC1
STEADY INPUT
OUTPUT AFTER INPUT DISCONNECTION
INPUT POWER
OUTPUT POWER

FIG.7


1002
BRANCHING APPARATUS
UPLINK
DOWNLINK
A
B
UPLINK
DOWNLINK
111:CPL
PD
211
801:CPL
LD
711
601:CPL
511:FIL
602:CPL
521:FIL
603:CPL
802:CPL
121:CPL
PD
221
LD
721
604:CPL
541:FIL
804:CPL
141:CPL
LD
741
PD
241
CTL
400
531:FIL
803:CPL
LD
731
131:CPL
PD
231
C1
C2
UPLINK
DOWNLINK
UPLINK
DOWNLINK

DIVERGING DEVICE WITH OADM FUNCTION AND WAVELENGTH DIVISION MULTIPLEXING OPTICAL NETWORK SYSTEM AND METHOD THEREFOR

TECHNICAL FIELD

The present invention relates to prevention of deterioration in signal quality during a cable fault of a wavelength multiplexing optical network system.

BACKGROUND ART

As an optical network system including three or more stations according to wavelength multiplexing in wavelength multiplexing optical transmission, an optical network system using a wavelength branching apparatus (or diverging device) having optical adding/dropping functions (OADM: Optical Add Drop Multiplexer) has been proposed. Due to the OADM, a signal can be arbitrarily inserted (added) or extracted (dropped) in units of wavelength of light.

In addition, unlike a fiber branching apparatus, in the wavelength branching apparatus having the OADM, in order to perform the wavelength adding/dropping, a signal band in one optical fiber is divided for communication among three stations. In this case, there is a problem in that, if a cable fault occurs in an arbitrary branch, a quality of a signal communicating between remaining two branches is deteriorated. This problem will be described in detail. In a case where a cable fault occurs, a signal which is to be originally inserted is not multiplexed. Therefore, the number of channels of main signals is decreased. Since a power of a relay is almost constant, a decrease in number of channels of main signals leads to an increase in channel power. In addition, there is a problem in that transmission characteristic according to a nonlinear effect of a transmission line is deteriorated due to the increase in channel power.

Various techniques have proposed in order to prevent the deterioration in signal quality according to the cable fault.

For example, in a technique disclosed in PTL 1, a dummy light beam for compensating for optical level is disposed in a transmission band (for example, a band L**1** in the case of communication between A and B); an interval of cable disconnection is detected from each of terminal station apparatuses A, B, and C in the entire network system; the dummy light beam which is optimized in terms of signal quality is controlled.

In a technique disclosed in PTL 2, the deterioration in signal quality is prevented by switching an uplink signal and a downlink signal by using a matrix switch during cable disconnection.

CITATION LIST

Patent Literature

{PTL 1} Japanese Patent Application Laid-Open No. 2010-226167

{PTL 2} Japanese Patent Application Laid-Open No. 10-173598

SUMMARY OF INVENTION

Technical Problem

The deterioration in signal quality can be prevented by using the above-described techniques. However, the above-described techniques have the following problems.

For example, like the technique disclosed in PTL 1, in a case where each terminal station apparatus controls a dummy light beam, there are problems as follows.

(1) Since the system is managed in the entire network, the control is complicated.

(2) In order to perform the control, there is a possibility that signal deterioration (in the worst case, communication disconnection) may occur for a certain time interval.

(3) Essentially, during cable disconnection, each signal power may not be maintained in the same state in each branch of the branching apparatus, and signal deterioration occurs.

There are the above-described problems.

In addition, in order to implement the technique disclosed in PTL 2, a matrix switch and an apparatus for controlling the matrix switch are needed. Therefore, there is a problem in that the configuration is complicated.

Accordingly, the present invention is to provide a branching apparatus which does not require controlling by a terminal station apparatus and changing of a path and has an OADM function capable of preventing deterioration in signal quality at the occurrence of a cable fault, a wavelength multiplexing optical network system, and a method therefor.

Solution to Problem

According to a first aspect of the present invention, there is provided a wavelength branching apparatus connected to three or more stations, wherein an uplink signal received from each of the stations is monitored; if a lack of the uplink signal received from any one of the stations is detected, a dummy light beam is output instead of the lacked signal; the dummy light beam and an uplink signal received from a station other than the any one of the stations are multiplexed/demultiplexed; and the multiplexed/demultiplexed signal is output, and wherein all the processes are performed in the wavelength branching apparatus.

According to a second aspect of the present invention, there is provided a wavelength multiplexing optical network system including: three or more terminal station apparatuses; a relay apparatus which is connected to the three or more terminal station apparatuses; and a wavelength branching apparatus which is connected to the three or more terminal station apparatuses through the relay apparatus, wherein the wavelength branching apparatus is the wavelength branching apparatus according to the first aspect of the present invention.

According to a third aspect of the present invention, there is provided a wavelength branching method performed by a wavelength branching apparatus connected to three or more stations, including: monitoring an uplink signal received from each of the stations; outputting a dummy light beam instead of a lacked signal if a lack of the uplink signal received from any one of the stations is detected; multiplexing/demultiplexing the dummy light beam and an uplink signal received from a station other than the any one of the stations; and outputting the multiplexed/demultiplexed signal, wherein all the processes are performed in the wavelength branching apparatus.

Advantageous Effects of the Invention

According to the present invention, a branching apparatus includes a circuit which detects disconnection of optical input power of each branch, an optical amplifier which compensates for the optical power, and the like, so that controlling by a terminal station apparatus and changing of a path are not required, and deterioration in signal quality at the occurrence of a cable fault can be prevented.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** A figure illustrates a basic configuration of a wavelength multiplexing optical transmission system according to an embodiment of the present invention.

FIG. **2** A figure illustrates a basic configuration of a branching apparatus according to the embodiment of the present invention.

FIG. **3** A figure illustrates a situation where fault occurs in a general wavelength multiplexing optical transmission system.

FIG. **4** A figure illustrates a behavior of an optical signal power during occurrence of fault in a general wavelength multiplexing optical transmission system.

FIG. **5** A figure illustrates a basic configuration of a first modified example of the embodiment of the present invention.

FIG. **6** A figure illustrates input/output characteristics of an optical amplifier according to the embodiment of the present invention.

FIG. **7** A figure illustrates a basic configuration of a second modified example of the embodiment of the present invention.

REFERENCE SINGS LIST

111, **112**, **121**, **122**, **131**, **132**, **141**, **142**: branching coupler
211, **212**, **221**, **222**, **231**, **232**, **241**, **242**: photodiode
311, **321**, **331**, **341**: optical amplifier
400: control circuit
511, **521**, **531**, **541**: optical filter
601, **602**, **603**, **604**, **801**, **802**, **803**, **804**: multiplexing/demultiplexing coupler
711, **721**, **731**, **741**: LD
1000, **1001**, **1002**: branching apparatus
2000: terminal station apparatus
3000: relay apparatus

DESCRIPTION OF EMBODIMENTS

First, embodiments of the present invention will be described in brief. In brief, the embodiment of the present invention is directed to an undersea cable system including three or more stations, where a function of compensating for an optical power level with respect to a cable fault occurring in an arbitrary branch of a branching apparatus is included inside the branching apparatus, so that deterioration in signal quality is suppressed.

Next, embodiments of the present invention will be described in detail with reference to the drawings.

FIG. **1** illustrates an overall configuration of a wavelength multiplexing optical network system including wavelength branching according to an embodiment of the present invention. Referring to FIG. **1**, the wavelength multiplexing optical network system according to the embodiment is configured to include a branching apparatus **1000**, a terminal station apparatus **2000**-A, a terminal station apparatus **2000**-B, a terminal station apparatus **2000**-C**1**, a terminal station apparatus **2000**-C**2**, and a plurality of relay stations **3000**.

The branching apparatus **1000** is an OADM branching apparatus, which has a unique configuration according to the embodiment. For the convenience of description, the configuration of the branching apparatus **1000** is not illustrated in

FIG. **1**. The detailed configuration of the branching apparatus **1000** will be described later with reference to FIG. **2**.

The branching apparatus **1000**, the terminal station apparatus **2000**-A, the terminal station apparatus **2000**-B, the terminal station apparatus **2000**-C**1**, and the terminal station apparatus **2000**-C**2** are terminal station apparatuses, which communicate optical signals with each other.

The relay station **3000** maintains an optical power at a constant level. The relay station **3000** outputs an optical signal of a substantially constant power irrespective of a power of an input optical signal.

Next, a communication method will be described in detail.

The terminal station apparatus **2000**-A, the terminal station apparatus **2000**-B, and the terminal station apparatus **2000**-C are terminal station apparatuses. The terminal station apparatus **2000**-A and the terminal station apparatus **2000**-B communicate with each other in a wavelength band L**1**. The terminal station apparatus **2000**-A and the terminal station apparatus **2000**-C**1** communicate with each other in a wavelength band S**1**. The terminal station apparatus **2000**-B and the terminal station apparatus **2000**-C**2** communicate with each other in a wavelength band S**2**. The S**1** and the S**2** are the same in terms of a signal band, and signals in communication in the S**1** and the S**2** are different from each other.

The terminal station apparatus **2000**-A transmits signals in both signal bands S**1** and L**1** in order to communicate with the terminal station apparatus **2000**-B and the terminal station apparatus **2000**-C. The signal output from the terminal station apparatus **2000**-A is 2-branched by the branching apparatus **1000** to be transmitted to the terminal station apparatus **2000**-B and the terminal station apparatus **2000**-C**1**. The branching apparatus **1000** blocks the signal band S**1** by a filter in the direction from the terminal station apparatus **2000**-A to the terminal station apparatus **2000**-B and multiplexes a signal in the signal band S**2** from the terminal station apparatus **2000**-C**2**.

Next, a detailed configuration of the branching apparatus **1000** will be described with reference to FIG. **2**. Referring to FIG. **2**, the branching apparatus **1000** is configured to include branching couplers (in figures and description hereinafter, appropriately referred to as "CPLs") **111**, **112**, **121**, **122**, **131**, **132**, **141**, and **142**, photodiodes (in figures and description hereinafter, appropriately referred to as "PDs") **211**, **212**, **221**, **222**, **231**, **232**, **241**, and **242**, optical amplifiers (in figures and description hereinafter, appropriately referred to as "AMPS") **311**, **321**, **331**, and **341**, a control circuit (in figures and description hereinafter, appropriately referred to as a "CTL") **400**, optical filters (in figures and description hereinafter, appropriately referred to as "FILs") **511**, **521**, **531**, and **541**, and multiplexing/demultiplexing couplers (in figures and description hereinafter, appropriately referred to as "CPLs") **601**, **602**, **603**, and **604**.

Each branching coupler detects an optical signal power which is incident from the uplink direction.

Each photodiode performs photo-electric conversion on the optical signal branched by the branching coupler.

Each optical amplifier can amplify an optical signal and output amplified spontaneous emission (hereinafter, referred to as an "ASE light beam") as a dummy light beam.

The control circuit **400** determines whether or not disconnection is detected from the signal which is photo-electrically converted by each photodiode and controls each optical amplifier.

Each optical filter is configured to determine adding/dropping of an optical signal band. Each multiplexing/demultiplexing coupler performs adding/dropping.

Next, a case where a cable fault occurs will be described with reference to FIGS. **3** and **4**. Although the overall configuration of the system of the example illustrated in FIGS. **3** and **4** is the same as the configuration of the embodiment, a branching apparatus **4000** illustrated in FIGS. **3** and **4** is a general branching apparatus different from the branching apparatus **1000** according to the embodiment. In other words, FIGS. **3** and **4** are diagrams illustrating problems of a general technique.

FIG. **3** illustrates a case where a cable fault occurs between a station C (C**1** and C**2**) and a branching apparatus **4000**.

In a case where the cable fault occurs, a band S**2** (or band S**1**) is lost among the signal bands which are directed from the branching apparatus **4000** to the station B (or station A).

Due to the saturation characteristic (a characteristic where an optical power reaches a steady power by controlling excited light to be constant in a relay) of a relay **3000** between the branching apparatus **4000** and the station B (or station A), the signal power of the band L**1** is increased, and the signal quality is deteriorated due to an nonlinear effect occurring in the transmission line. The deterioration in signal quality is illustrated in FIG. **4**. Referring to FIG. **4**, the signal quality is deteriorated during the occurrence of the fault.

Next, operations in a case where the same cable fault occurs in the embodiment illustrated in FIGS. **1** and **2** rather than a general technique illustrated in FIGS. **3** and **4** will be described.

In the embodiment, irrespective of the occurrence of a cable fault, a signal before multiplexing/demultiplexing performed by a multiplexing/demultiplexing coupler from a normal situation and a signal output from each optical filter are monitored.

More specifically, an optical signal before multiplexing/demultiplexing performed by each branching coupler and an optical signal output from each optical filter are branched. The branched optical signal is converted into an electric signal by each photodiode to be input to the control circuit **400**.

The control circuit **400** detects input disconnection by monitoring the signal (signal before the multiplexing/demultiplexing by the multiplexing/demultiplexing coupler) incoming in the uplink direction, which is input from the PD **211** (or PD **221**, PD **231**, PD **241**). Therefore, a lack of to-be-multiplexed/demultiplexed wavelength band can be detected. Namely, the control circuit **400** can detect disconnection of the optical signal incoming in the uplink direction.

In addition, if the control circuit **400** detects the lack of to-be-multiplexed/demultiplexed wavelength band actually due to actual occurrence of a cable fault, the control circuit **400** controls the AMP **311** (or AMP **321**, AMP **331**, AMP **341**) so that the input of the PD **212** (or PD **222**, PD **232**, PD **242**) is constant. More specifically, an ASE light beam is generated in each optical amplifier, so that the signal power outgoing in the downlink direction is compensated for. Namely, in the embodiment, the output after passing through each optical filter can be fed back.

A certain signal is taken as an example, and the embodiment and the general technique illustrated in FIGS. **3** and **4** are compared to each other.

In a case where a cable fault occurs between the branching apparatus **1000** and the terminal station apparatus **2000**-C**1** or the terminal station apparatus **2000**-C**2** as illustrated in FIG. **3**, in the embodiment, the control circuit **400** recognizes based on the output of the PD **241** (or PD **231**) that a cable fault occurs in the terminal station apparatus **2000**-C**2** (or terminal station apparatus **2000**-C**1**) side. Next, an ASE light beam is generated by the AMP **341** (or AMP **331**). In addition, the output of the PD **242** (or PD **232**) is monitored, and the output is fed back, so that the AMP **341** (or AMP **331**) is adjusted such that the optical power is constant. Therefore, the ASE light beam is added to the band S**2** (or band S**1**), so that the optical signal power outgoing from the branching apparatus **1000** is constant. Accordingly, the signal quality is maintained.

Next, a first modified example of the embodiment will be described. Although an overall configuration of the first modified example is the same as that of FIG. **1**, a branching apparatus **1001** configured by simplifying the configuration of the branching apparatus **1000** illustrated in FIG. **2** is used.

Referring to FIG. **5**, the branching apparatus **1001** is configured to include CPLs **111**, **121**, **131**, and **141**, PDs **211**, **221**, **231**, and **241**, AMPs **311**, **321**, **331**, and **341**, a CTL **400**, FILs **511**, **521**, **531**, and **541**, and CPLs **601**, **602**, **603**, and **604**.

Namely, the branching apparatus **1001** has a configuration where the branching couplers CPLs **112**, **122**, **132**, and **142** and the photodiodes PDs **212**, **222**, **232**, and **242** are removed from the branching apparatus **1000**.

In addition, although the output after passing through each optical filter is fed back in the branching apparatus **1000**, in a case where input disconnection is detected in the branching apparatus **1001**, an APC (auto power control) operating point of the optical amplifier is allowed to be changed, so that the power is operated so as to be constant.

This will be described with reference to FIG. **6**. In general, in a case where steady input is applied, the optical amplifier is operated at an APC **1** to constitute the branching apparatus. At this time, in a case where input disconnection is detected by the PD **211** (or PD **221**, PD **231**, PD **241**), the control circuit **400** changes the APC operating point to an APC **2** and sets an AMP **311** (or AMP **321**, AMP **331**, AMP **341**) so that the output after the input disconnection is equal to the output in the case of the steady input. Therefore, the control circuit **400** compensates for the signal power.

Next, a second modified example of the present invention will be described.

The second modified example is an example where LDs (Laser diodes) are used instead of optical amplifiers. More specifically, the branching apparatus **1002** is configured to include CPLs **111**, **121**, **131**, and **141**, PDs **211**, **221**, **231**, and **241**, a CTL **400**, FILs **511**, **521**, **531**, and **541**, CPLs **601**, **602**, **603**, and **604**, LDs **711**, **721**, **731**, and **741**, and CPLs **801**, **802**, **803**, and **804**.

As oscillation wavelengths of the LDs **711**, **721**, **731**, and **741**, wavelengths which are not influenced by blockage of the optical filters are appropriately selected. During the signal blocking, the LDs **711**, **721**, **731**, and **741** are operated so that the generated light beams are inserted into the CPLs **801**, **802**, **803**, and **804** as multiplexing/demultiplexing couplers.

In FIG. **7**, the CPLs **801**, **802**, **803**, and **804** are disposed at the front stage of the FILs **511**, **521**, **531**, and **541**. However, the CPLs **801**, **802**, **803**, and **804** may be disposed at the rear stage of the FILs **511**, **521**, **531**, and **541**.

According to the present invention described above, a branching apparatus includes a circuit which detects disconnection of optical input power of each branch and an optical amplifier which compensates for the optical power, so that deterioration in signal quality in an OADM network can be suppressed. Therefore, it is possible to obtain an effect in that a robust OADM network system can be provided.

In addition, in the embodiment, an output of a filter (for example, FIL **511** of FIG. **1**) is monitored, and an optical power of the AMP **311** is controlled, so that an optical power of which wavelength is to be added can be controlled. Namely, since the ASE of the optical amplifier has the entire wavelength bands, the optical power just after the AMP **311** (=just before the FIL **511**) is monitored, so that the problem that appropriate add power may not be obtained can be solved in the embodiment.

In addition, if a dummy light beam is inserted from a terminal station, there is a problem in that an interval occurs where a total power in the optical fiber is increased according to an increase in the dummy light beam during the cable fault in an interval from the terminal station to the branching apparatus, or a defect occurs in an interval (interval from the terminal station apparatus **2000**-A to the branching apparatus **1000** in FIG. **1**, that is, an interval before dropping in the branching apparatus **1000**). However, in the embodiment, since the dummy light beam is inserted inside the branching apparatus rather than the terminal station, it is possible to obtain an advantage in that the above-described defect does not occur.

The present invention is based on Japanese Patent Application No. 2011-094126, filed on Apr. 20, 2011, and priority under the Paris Convention is claimed to Japanese Patent Application No. 2011-094126. The entire content disclosed in Japanese Patent Application No. 2011-094126 is incorporated herein by reference.

Although representative embodiments of the present invention are described in detail, it should be noted that various changes, substitutions, and alternatives may be available without departing from the spirit of the invention and the scope of the invention defined by the claims. In addition, although the claims are amended in the course of application, the inventors intend that the equivalent range of the claimed invention should be maintained.

A portion of or all of the above-described embodiment may be disclosed as the following supplementary notes, but the prevent invention is not limited thereto.

(Supplementary note 1) A wavelength branching apparatus connected to three or more stations, wherein an uplink signal received from each of the stations is monitored; if a lack of the uplink signal received from any one of the stations is detected, a dummy light beam is output instead of the lacked signal; the dummy light beam and an uplink signal received from a station other than the any one of the stations are multiplexed/demultiplexed; and the multiplexed/demultiplexed signal is output, and wherein all the processes are performed in the wavelength branching apparatus.

(Supplementary note 2) The wavelength branching apparatus according to supplementary note 1, includes: a first branching coupler which branches the uplink signal received from each of the stations before the multiplexing/demultiplexing; and a first photodiode which converts the signal branched by the first branching coupler to an electric signal, wherein the lack of the uplink signal is detected by monitoring the electric signal converted by the first photodiode.

(Supplementary note 3) The wavelength branching apparatus according to supplementary note 1 or 2, further includes an optical amplifier which generates the dummy light beam; an optical filter which passes the dummy light beam before the multiplexing/demultiplexing; a second branching coupler which branches a signal after the passing through the optical filter; and a second photodiode which converts the signal branched by the second branching coupler to an electric signal, wherein the occurrence of the dummy light beam by the optical amplifier is controlled by monitoring the electric signal converted by the second photodiode so that input to the second photodiode is constant.

(Supplementary note 4) The wavelength branching apparatus according to supplementary note 1 or 2, further includes an optical amplifier which amplifies the uplink signal received from each of the stations before the multiplexing/demultiplexing, wherein, when the lack of the uplink signal is not detected, the optical amplifier is operated at a first APC (Auto Power Control) operating point; and when the lack of the uplink signal is detected, the optical amplifier is operated at a second APC (Auto Power Control) operating point.

(Supplementary note 5) The wavelength branching apparatus according to supplementary note 1 or 2, wherein, if the lack of the uplink signal is detected, a light beam obtained by operating an LD (laser diode) at a wavelength which is not influenced by blockage of an optical filter is output instead of the lacked signal.

(Supplementary note 6) A wavelength multiplexing optical network system, includes: three or more terminal station apparatuses; a relay apparatus which is connected to the three or more terminal station apparatuses; and a wavelength branching apparatus which is connected to the three or more terminal station apparatuses through the relay apparatus, wherein the wavelength branching apparatus is the wavelength branching apparatus according to any one of supplementary notes 1 to 5.

(Supplementary note 7) A wavelength branching method performed by a wavelength branching apparatus connected to three or more stations, including: monitoring an uplink signal received from each of the stations; outputting a dummy light beam instead of a lacked signal if a lack of the uplink signal received from any one of the stations is detected; multiplexing/demultiplexing the dummy light beam and an uplink signal received from a station other than the any one of the stations; and outputting the multiplexed/demultiplexed signal, wherein all the processes are performed in the wavelength branching apparatus.

(Supplementary note 8) The wavelength branching method according to supplementary note 7, wherein the wavelength branching apparatus further includes: a first branching coupler which branches the uplink signal received from each of the stations before the multiplexing/demultiplexing; and a first photodiode which converts the signal branched by the first branching coupler to an electric signal, wherein the lack of the uplink signal is detected by monitoring the electric signal converted by the first photodiode.

(Supplementary note 9) The wavelength branching method according to supplementary note 7 or 8, wherein the wavelength branching apparatus further includes: an optical amplifier which generates the dummy light beam; an optical filter which passes the dummy light beam before the multiplexing/demultiplexing; a second branching coupler which branches a signal after the passing through the optical filter; and a second photodiode which converts the signal branched by the second branching coupler to an electric signal, wherein the occurrence of the dummy light beam by the optical amplifier is controlled by monitoring the electric signal converted by the second photodiode so that input to the second photodiode is constant.

(Supplementary note 10) The wavelength branching method according to supplementary note 7 or 8, wherein the wavelength branching apparatus further includes an optical amplifier which amplifies the uplink signal received from each of the stations before the multiplexing/demultiplexing, wherein, when the lack of the uplink signal is not detected, the optical amplifier is operated at a first APC (Auto Power Control) operating point; and when the lack of the uplink signal is detected, the optical amplifier is operated at a second APC (Auto Power Control) operating point.

(Supplementary note 11) The wavelength branching method according to supplementary note 7 or 8, wherein, if the lack of the uplink signal is detected, a light beam obtained by operating an LD (laser diode) at a wavelength which is not influenced by blockage of an optical filter is output instead of the lacked signal.

INDUSTRIAL APPLICABILITY

The present invention is very appropriate to, for example, an undersea cable system employing an optical inserting-branching apparatus (OADM-BU (Optical Add Drop Multiplexing-Branching Unit)).

The invention claimed is:

1. A wavelength branching apparatus coupled to three or more stations, comprising:

a first monitor configured to monitor an uplink signal received from each of the stations;

an optical amplifier configured to, if a lack of the uplink signal received from any one of the stations is detected, output a dummy light beam on behalf of the lacked signal;

an optical filter through which the dummy light from the optical amplifier is passed;

a converter configured to convert the signal which is output from the optical filter into an electric signal;

a second monitor configured to monitor the electric signal;

a controller configured to control the dummy light from the optical amplifier on the basis of the monitoring result;

a multiplexer configured to multiplex the dummy light beam and an uplink signal received from a station other than the any one of the stations; and

a multiplexed signal output portion configured to output the multiplexed signal.

2. The wavelength branching apparatus according to claim **1**, further comprising:

a first branching coupler which branches the uplink signal received from one of the three or more stations before the multiplexing; and

a first photodiode which converts the signal branched by the first branching coupler to an electric signal,

wherein the lack of the uplink signal is detected by monitoring the electric signal converted by the first photodiode.

3. The wavelength branching apparatus according to claim **1**, further comprising:

a second branching coupler which branches a signal after the passing through the optical filter; and

a second photodiode which converts the signal branched by the second branching coupler to an electric signal,

wherein the occurrence of the dummy light beam by the optical amplifier is controlled by monitoring the electric signal converted by the second photodiode so that input to the second photodiode is constant.

4. The wavelength branching apparatus according to claim **1**, further comprising an optical amplifier which amplifies the uplink signal received from each of the stations before the multiplexing,

wherein, when the lack of the uplink signal is not detected, the optical amplifier is operated at a first APC (Auto Power Control) operating point; and when the lack of the uplink signal is detected, the optical amplifier is operated at a second APC (Auto Power Control) operating point.

5. The wavelength branching apparatus according to claim **1**, wherein, if the lack of the uplink signal is detected, a light beam obtained by operating an LD (laser diode) at a wavelength which is not influenced by blockage of an optical filter is output as the dummy light on behalf of the lacked signal.

6. A wavelength multiplexing optical network system, comprising:

three or more terminal station apparatuses;

a wavelength branching apparatus which is coupled to the three or more terminal station apparatuses; and

relay apparatuses each of which is configured to couple any one of the three or more terminal station apparatuses and the wavelength branching apparatus,

wherein the wavelength branching apparatus is the wavelength branching apparatus according to claim **1**.

7. The wavelength branching apparatus according to claim **1**, further comprising:

a second branching coupler which branches a signal after the passing through the optical filter; and

a second photodiode which converts the signal branched by the second branching coupler to an electric signal.

8. The wavelength branching apparatus according to claim **1**, wherein after passing through the optical filter, the dummy light is fed back to the optical amplifier which then outputs the dummy light.

9. The wavelength branching apparatus according to claim **1**, further comprising a second optical filter through which the dummy light from the optical amplifier is passed,

wherein after passing through the optical filter and the second optical filter, the dummy light is fed back to the optical amplifier which then outputs the dummy light.

10. A wavelength branching method performed by a wavelength branching apparatus which is coupled to three or more stations, the method comprising:

monitoring an uplink signal received from each of the stations;

outputting a dummy light beam on behalf of a lacked signal if a lack of the uplink signal received from any one of the stations is detected at an optical amplifier;

passing the dummy light from the optical amplifier through an optical filter;

converting the signal which is output from the optical filter into an electric signal;

monitoring the electric signal;

controlling the dummy light from the optical amplifier on the basis of the monitoring result;

multiplexing the dummy light beam and an uplink signal received from a station other than the any one of the stations; and

outputting the multiplexed signal.

11. The wavelength branching method according to claim **10**, wherein the wavelength branching apparatus further includes:

a first branching coupler which branches the uplink signal received from one of the three or more stations before the multiplexing; and

a first photodiode which converts the signal branched by the first branching coupler to an electric signal, and wherein the lack of the uplink signal is detected by monitoring the electric signal converted by the first photodiode.

12. The wavelength branching method according to claim **10**, wherein the wavelength branching apparatus further includes:

an optical amplifier which generates the dummy light beam;

an optical filter which passes the dummy light beam from the optical amplifier;

a second branching coupler which branches a signal after the passing through the optical filter; and

a second photodiode which converts the signal branched by the second branching coupler to an electric signal, wherein the occurrence of the dummy light beam by the optical amplifier is controlled by monitoring the electric signal converted by the second photodiode so that input to the second photodiode is constant.

13. The wavelength branching method according to claim **10**, wherein the wavelength branching apparatus further includes an optical amplifier which amplifies the uplink signal received from each of the stations before the multiplexing,

wherein, when the lack of the uplink signal is not detected, the optical amplifier is operated at a first APC (Auto Power Control) operating point; and when the lack of the uplink signal is detected, the optical amplifier is operated at a second APC (Auto Power Control) operating point.

14. The wavelength branching method according to claim **10**,

wherein, if the lack of the uplink signal is detected, a light beam obtained by operating an LD (laser diode) at a wavelength which is not influenced by blockage of an optical filter is output as the dummy light on behalf of the lacked signal.

15. The wavelength branching method according to claim **10**, wherein the wavelength branching apparatus further includes:

an optical amplifier which generates the dummy light beam;

a second branching coupler which branches a signal from the optical amplifier; and

a second photodiode which converts the signal branched by the second branching coupler to an electric signal,

wherein the occurrence of the dummy light beam by the optical amplifier is controlled by monitoring the electric signal converted by the second photodiode so that input to the second photodiode is constant.

16. The wavelength branching method according to claim **10**, further comprising, after passing through the optical filter, feeding back the dummy light to the optical amplifier which then outputs the dummy light.

17. The wavelength branching method according to claim **10**, further comprising passing the dummy light from the optical amplifier through a second optical filter; and

after passing through the optical filter and the second optical filter, feeding back the dummy light to the optical amplifier which then outputs the dummy light.

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